EGR244 Dynamics

Lecture

WF 10:05am–11:20pm, CIEMAS B-1466

Labs

Section 6	Thu 11:45am-1:00pm	Section 9	Fri 3:05pm-4:20pm
Section 7	Thu 1:25pm-2:40pm	Section 10	Fri 4:40pm-5:55pm
Section 8	Fri 11:45am-1:00pm	Section 12	Tue 11:45am-1:00pm

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Textbook: L.G. Kraige, J.L. Meriam, *Engineering Mechanics Dynamics*, John Wiley & Sons, 6th Ed. Typeset instructor notes will be used for certain materials that are not covered in the text.

Communication: Check Sakai frequently, i.e., daily. In the event I must communicate urgently to the class then I will send an email in addition to posting an announcement.

Grading Scheme:

Labs:	15	Exams (best 2 of 3 exams):	50
Homework/Quizzes:	20	Course Project (gravity car):	15
		Total:	**100**

Exams: There will be three exams and the best two exams will be counted towards your grade, i.e. each exam is worth 25% of your grade. If you miss one of the regular exams for any reason the remaining two exams will count. No make up exams will be given.

Homework: You must use the homework format described on Sakai. Homework solutions will be available after the deadline.

- Work submitted for a grade in this course will typically be due by 4:00pm on a Friday. For specific due dates you are referred to the course Sakai website. You should deposit your homework in the appropriately labeled box located in 118 Hudson Hall.
- Collaboration on homework problems is strongly encouraged, but each person should submit his/her own work. Cite all collaborators—persons who provided any source of assistance. If none, write "Collaborators: none".

Late work: Homework and lab report grades will be affected by turning in late work. The following explains how the late policy will work.

- **Late homework:** No credit will be given for late homework unless an extension is granted prior to the submission date.
- **Late lab report:**For each working day that any lab report is turned in late 10 points will be deducted from your lab average (out of 100 points). Late penalties are not accrued for weekends or University holidays. Late penalties will accrue until either the lab report is submitted or 3 working days have passed since the deadline.

Quizzes: You will be given a 10-20 minute quiz approximately every other week during lecture. The question will be related to the material covered in class the previous two weeks or it will be a previous homework problem. While there will be no make-up quiz for an excused absence, I will automatically drop your lowest quiz grade. Any additional excused absences will require a meeting with the instructor.

Course project: The gravity car project will be used to emphasize the application of the class concepts to achieve faster speeds. Details for this assignment are described in a separate document.

Computer use: It is the formal policy of this class that computers are necessary. This includes access to and the use of the Internet. Additional requirements are the use of Matlab.

Class attendance: Attendance at Lectures and Laboratories is mandatory.

Other behavior expectations: Students are expected to take a sincere interest in learning the classroom material and to abide by the Duke Community Standard (DCS). Keeping with this expectation, students should: 1) not create distractions (i.e. turn cell phones off, put laptops and newspapers/magazines away); and 2) show up to class on time; and 3) be courteous to other students and the instructor. Violations of the DCS will be dealt with appropriately and may involve the Undergraduate Conduct Board.

Help: Good study habits are absolutely essential to your success in this course. If you feel you are having difficulty keeping up with work, please talk to me as soon as possible so we can figure out a plan to get you and your study habits back on track. The TAs and I will make every effort to assist you but please restrict your in-person inquiries to our office hours and immediately after class.

Regrade requests: Errors, oversights, and misinterpretations may occur. If there is an error in your grade (e.g., the total number of points incorrectly added) or you feel that the grade you received is not commensurate for your solution then you may submit a regrade request. For quizzes and lab reports, you must contact the TA that graded the assignment informing her/him about your request. You must then return the assignment to the TA with a written request detailing why you think your grade should be reconsidered. This regrade request should occur within 7 days after the announcement to pick up the graded assignment in question has been posted on Sakai. For exams, no regrade requests will be accepted until exactly one week after the graded exam has been returned. To submit a regrade request, you must: 1) review the posted exam solution, and 2) attach a written request explaining why I should reconsider your grade. You must hand me your exam with the attached request either before or after the class one week after the exams are returned. Note that by submitting a regrade request you understand that your whole work can be re-evaluated and not only the problems you requested.

Course description: This class covers the principles of dynamics of particles, rigid bodies, and selected nonrigid systems with emphasis on engineering applications. Kinematic and analysis of dynamics problems using graphical, computer and analytical vector techniques. Absolute and relative motion analysis. Work-energy, impact and impulse-momentum. Application of Lagrange equations to dynamic problems. Laboratory experiments.

Measurable Outcomes: Students will demonstrate their ability to:

1. Select and define appropriate coordinate systems for particle and rigid body problems, and determine the unknowns among position, velocity and acceleration, given a set of constraints on the kinematics of a particle or body.

2. Derive differential equations of motion for a particle, using a variety of force models, such as gravity, coulomb friction, viscous damping and spring stiffness, and solve the equations for selected particle problems.

3. Choose and apply the appropriate work/energy and impulse/momentum relations to find relationships between dynamic states of a particle, and solve for the dynamic states in selected particle problems.

4. Derive differential equations of motion for a body in plane motion using Newtons laws and moments of inertia, and solve the equations for selected problems.

5. Choose and apply the appropriate integral relationships of work/energy, linear and angular impulse/momentum to find relationships between dynamic states of a rigid body in plane motion, and solve these equations for selected plane motion problems.

6. Use Lagrange's Equations in a variety of settings to derive equations of motion.

7. Design an experiment to measure dynamic response in a one dimensional problem and determine the limits of a linear model.

Lab schedule

Week	Lab
1	No lab
2	OH
3	OH
4	Coefficient of restitution (LR)
5	OH
6	OH
7	Euler Simulation (LR)
8	OH
9	Gravity car parameter estimation (LR)
10	OH
11	OH
12	OH
13	OH
14	OH
15	OH

Note: '**LR**' indicates that a report should be submitted for this lab. Check the course website for the format and the due date. '**OH**' indicates office hours.

Lecture Schedule

Week	Date	Topics	Homework problems
1	1/11	Introduction & overview	
2	1/16	Review of concepts from Statics (vectors, equivalent force systems, and friction)	1.3, 1.14, 2.29, 2.49, BP
	1/18	Cartesian and path coordinate systems	2.85, 2.116, 2.176, SP2.15, SP2.16, BP
3	1/23	Particle Kinetics (Newton's 2^{nd} Law)	3.18, 3.21, 3.35, BP
	1/25	Work and Energy	3.116, 3.132, 3.145 BP
4	1/30	Impulse and Momentum	SP3.26, 3.230, 3.239, 3.248
	2/1	Different types of impact	3.254, 3.259, 3.262, 3.263, 3.268, 3.269
5	2/6	Systems of particles, finish particle (point mass) dynamics, Angular momentum	SP4.3, 4.6, 4.24, 4.25, 4.30
	2/8	Planar kinematics of rigid bodies	5.25, SP5.4, 5.32, 5.54, 5.72
6	2/13	Rigid body kinetics, Mass moments of inertia I_G	SPB1(p.668), B8(p.671), B11, B49 (p.679)
	2/15	Impulse and Momentum of rigid bodies	SP6.16, 6.205, 6.206, BP
7	2/20	Deriving equations of motion with Lagrange's Equations and comparison to Newton's 2^{nd} Law	BP
	2/22	Midterm 1	
8	2/27	Deriving equations of motion with Lagrange's Equations and comparison to Newton's 2^{nd} Law	BP
	3/1	SDOF undamped free vibration	8.15, 8.18, 8.25, ,8.26, 8.27
9	3/6	SDOF damped free vibration	8.35, 8.38, 8.41
	3/8	SDOF forced vibration (harmonic and base excitation) (Spring break begins at 7pm)	8.57, 8.59, 8.61, 8.66, 8.71
10	3/20	Vibration of rigid bodies	8.83, 8.87, 8.89, 8.92
	3/22	Midterm 2	
11	3/27	3D Rigid Body kinematics	7.19, 7.20, 7.23, 7.26, 7.40, 7.48, 7.51
	3/29	3D Rigid Body kinematics	
12	4/3	3D Rigid Body kinetics: angular momentum, products of inertia, and kinetic energy	SPB4, B.56, B.58, B.63, 7.61, 7.64, 7.67
	4/5	Car races	
13	4/10	3D Rigid body kinetics: momentum and energy, equations of motion, parallel plane motion	SP7.7, 7.75, 7.84, 7.87
	4/12	Gyroscopic motion: steady precession	7.106, 7.116, 7.118, 7.122
14	4/17	Gyroscopic motion: steady precession	
	4/19	Review (Course project due)	
15	4/24	Midterm 3	

Note: The following notation was used in the practice problems column above.
- BP means additional problems, such as problems put on the board, will be assigned during class.
- SP2.6 means you should work 'sample problem' 2.6 from the course text.
- B49 means problem 49 in Appendix B of the course text.